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Digital Synchroscope

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Abstract : *Synchronization of two alternators is very important process at generating station. Synchronization is done to connect more alternator's parallel to achieve the high demand of power. For this process, synchroscope method is frequently used. Synchroscope is a device which shows the differences of frequency and phase angle between two powers by deflecting pointer clockwise and anticlockwise. We also required additional instruments for measuring frequency and voltage. The intention of this paper is to propose the methodology of a single device which shows the required parameters on single display and also offers the automatic synchronization of alternators. It is fast, cost effective and precise to be used for monitoring.*
Keywords - *Synchroscope, Alternators, parallel operation, Synchronization, Arduino.*

I. INTRODUCTION

Nowadays the power demand is increasing day by day to achieve this high demand the parallel operation of alternators at generating stations are the needs in the electrical power system. This is particularly important when reliability and flexibility are required in the system. If there is a failure of any one alternator that does not affect the total power failure, others can maintain the system in order. Therefore failed alternator can be removed for preventive maintenance and shutdown. The parallel operation of the alternator also offers a future extension another unit can be easily installed which will increase the power generation capacity. The important process in the parallel operation of the alternator is synchronizing the alternator. Mainly the alternators are connected to the bus bar therefore connecting one alternator to the alternator or bus bar without creating a disturbance in bus synchronization process is a must.

Synchronization of the alternator is done by some methods or techniques that as three dark lamp method, two bright lamps and one dark lamp method, three bright lamp method, and synchroscope method. From these methods, the synchroscope method is widely used. It is a device by which the difference in frequency and phase between two voltages of the alternator can be easily indicated. It is generally a split-phase motor where torque is developed when there is a difference in frequencies. The pointer will deflect either clockwise or anticlockwise direction according to the incoming machine's slow or fast compared to running alternators. This device can't measure the voltage and frequency. Therefore we required separate instruments to measure or monitor the voltage and the frequency of the alternator, which automatically makes the system costly and bulky.

This paper accentuates the digital types in cross scope which is more accurate and cost-effective. This device will display all required parameters on a single screen so no other additional instruments are required. Also, it provides automatic operation of synchronization and it is easy to operate.

At the time of the synchronization process, we have to make sure that four parameters align between the alternators.

1. Phase sequence of an incoming alternator and infinite bus bar must have the same.
2. The voltage of both the alternator and infinite bus bar must be the same.
3. The frequency of the incoming alternator and running alternator or bus bar is equal.
4. The phase angle difference between an incoming alternator and a running alternator must be zero.

II. LITERATURE REVIEW

[1] M. T. A. Siddiqi, M. M. Rasul and S. M. Hossain, "Automatic Synchronization Unit for Marine Alternators", International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST), 2021.

Synchronization of generators is veritably important to increase the capacity of an electrical system. The current process of synchronizing is complicate and time consuming. To overcome all the downsides of current system. The motive of this paper to give a simple automated result for synchronization of two marine alternators in a cost-effective manner. The advanced design of automatic synchronizer ensures quickly and exact outputs, it's reliable, cost effective, programmable, fluently replicable, simple to monitor and easy to maintain. Thereby it appears to be a conducive result for parallel operation of alternators on board marine ships. The designed automated synchronizing unit has numerous spectacular features which can replace the conventional technologies.

[2] S. Sheeba Rani1 , V. Gomathy, R. Geethamani, Rameez Khan.R , Mohan Raj.D, "Embedded Design in Synchronization of Alternator Automation", International Journal of Engineering & Technology,2018.

A new method for automatic synchronization of alternator has been developed without the need of manual operation. Alternator can be connected automatically to the bus bar with the control unit. The voltage, phase sequence, phase angle and frequency of the incoming alternator is compared with the infinite bus bar with the help of various sensing modules and controlled by microcontrollers. If the conditions are observed to be auspicious then automated synchronization is done with a previous indication. Synchronization method is cost-effective, reliable, quick and precise to be control, monitoring and parallel operation of alternator**.**

[3] R. C. Schaefer, "The art of generator synchronizing, "2016 IEEE Pulp, Paper & Forest Industries Conference (PPFIC), 2016.

This paper presents a review of power system synchronization, proper sync- check collaboration, and fast synchronization techniques. When paralleling two sources, it's pivotal that the interconnecting circuit breaker be closed only when both sources has same voltage, frequency, and phase sequence. Power system operation is bettered by applying a thorough understanding of synchronization and synchronized ending.

[4] Shawon Sen, Prasenjit Mazumder, Md. Hasibul Jamil3, Rahul Chowdhury, "Design & Construction of a Low-Cost Quasi Automatic Synchronizer for Alternators", International Journal of Engineering Research & Technology (IJERT), 2014.

Give an explanation of the automatic synchronizing process for three phase alternators. This design of automatic synchronizer includes separate voltage, frequency and phase sequence measurement in respect to the incoming generator. When these three parameters of both generators and bus are matched then both are connected electrically using a relay. This design reduces installation cost, maintenance cost for synchronization in power plants.

III. METHODOLOGY

Arduino Nano 328 p microcontroller is used for controlling and monitoring the system. Two ACS712 current sensors are connected to sense the current. The output pin of this sensors is connected to the analogue pin of Arduino pin i.e. A1 and A3. Also, two ZMPT101B voltage sensors are used for voltage measurement. Their output principle connected to the analogue pin AO and A2. 4zcd modules are used for converting the sinusoidal waveform into the square wave and which is in discrete form so the signal pins of ZCD circuit connected to the digital pin of a microcontroller D5, D6, D7, D8. The push button output is connected to the digital pin D3 and slider output pin connected to the pin D4. Also, a one pull down register is used with a push button to have a non-floating input. Here A4 and A5 pins are used as output pin for LED display. Similarly, D2 pin is also used as output pin where the relays connected. The 5-volt power supply is taken out from the microcontroller for all the sensors and switch.

IV. FIGURES

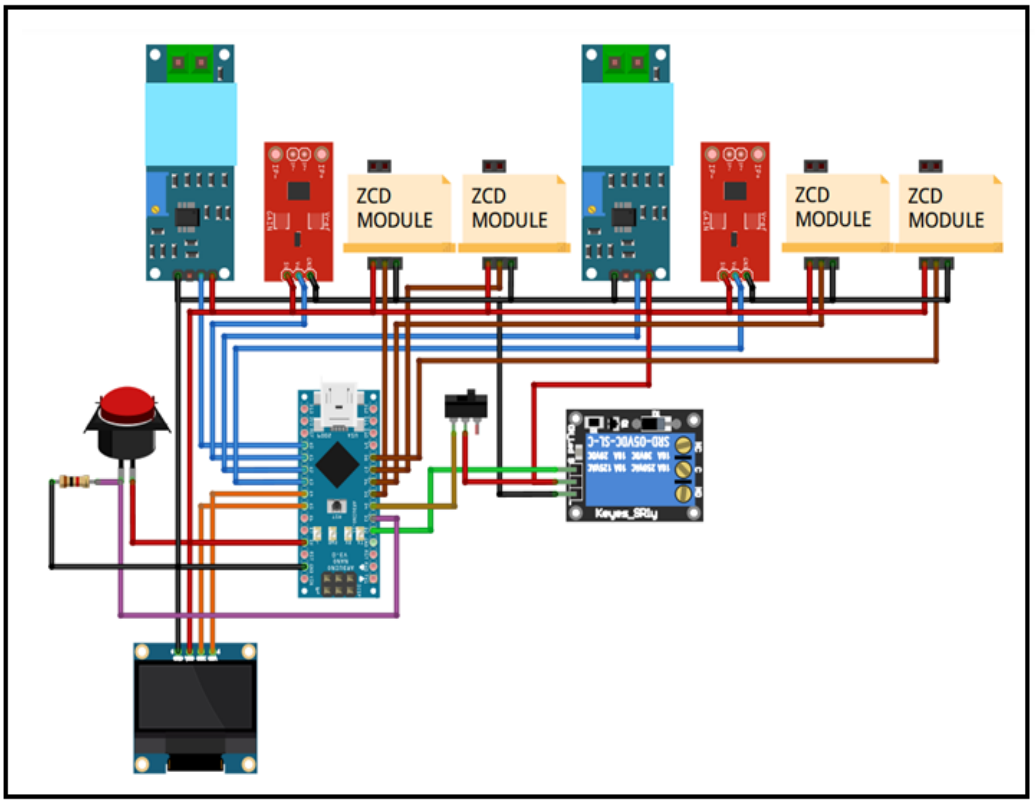

Figure 4.1: Circuit Diagram of Digital Synchroscope

V. CONCLUSION

The automatic synchronization of alternators can be achieved by satisfying synchronizing parameters by making voltage, frequency, phase sequence and phase angle of the incoming alternator equal to that of the reference infinite bus bar. Hence this technique successfully made automatic synchronization of alternators.

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